

540,355

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
8 July 2004 (08.07.2004)

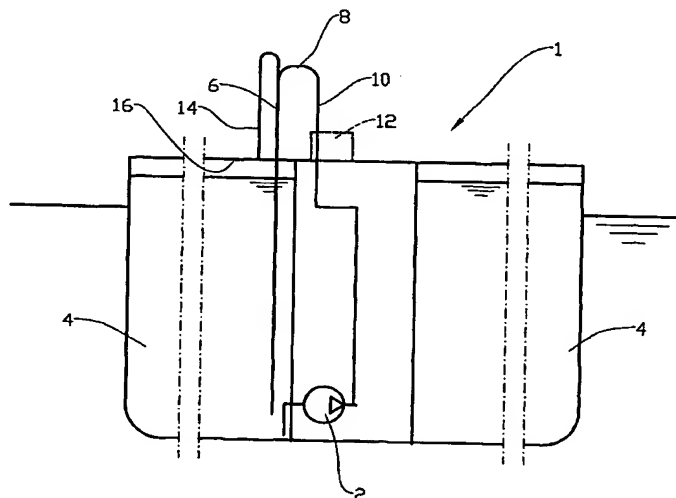
PCT

(10) International Publication Number
WO 2004/057231 A1

- (51) International Patent Classification⁷: **F17B 1/14**, B01D 5/00, B65D 90/30
- (21) International Application Number: PCT/NO2003/000433
- (22) International Filing Date: 22 December 2003 (22.12.2003)
- (25) Filing Language: Norwegian
- (26) Publication Language: English
- (30) Priority Data: 20026183 23 December 2002 (23.12.2002) NO
- (71) Applicant (for all designated States except US): **KNUTSEN OAS SHIPPING AS** [NO/NO]; P.O. Box 2017, N-5504 HAUGESUND (NO).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **LOTHE, Per** [NO/NO]; Snauhammar, N-5563 FØRRESFJORDEN (NO).
- (74) Agent: **HÅMSØ PATENTBYRÅ ANS**; P.O. Box 171, N-4302 SANDNES (NO).
- (81) Designated States (national): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, EG, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT (utility model), PT, RO, RU, SC, SD, SE, SG, SK (utility model), SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:
— with international search report

[Continued on next page]

(54) Title: A DEVICE FOR CONDENSING VOLATILE ORGANIC COMPOUNDS FROM A STORAGE OR TRANSPORT TANK INTO OIL



(57) Abstract: A device for condensing volatile organic compounds (VOC) from a storage or transport tank (4) into oil from the same or another storage or transport tank (4) via a downcomer (6), where the upper part (8) of the downcomer (6), which upper part has a cross sectional area that is essentially unreduced, is connected to a gas pipe (14), the gas pipe (14) communicating with the upper part (16) of the storage or transport tank (4), and where the upper part (8) of the downcomer (6) is arranged at a sufficient height above the upper part (16) of the storage or transport tank (4) to cause an inflow of gas from the upper part (16) of the storage or transport tank (4) due to the underpressure created in the upper part (8) of the downcomer (6) when oil flows down through the downcomer (6).

WO 2004/057231 A1

WO 2004/057231 A1



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A device for condensing volatile organic compounds from a storage or transport tank into oil.

This invention regards a device for reducing the proportion of volatile organic compounds VOC that separates out from oil, especially during transport in large tanks, such as is common e.g. during sea transport.

Crude oil normally contains fractions of light and heavy gases that, due to their volatility, cannot be transported with the liquid fraction of the crude oil. In terms of the technical aspects of the transport, it would be favourable if the crude oil were separated into a gas fraction, a liquid gas fraction and a liquid fraction. However, separating and transporting petroleum products from a production field in three fractions involves considerable extra costs, and as such the crude oil is normally separated into a gas fraction and a liquid fraction. The liquid gas phase is therefore divided into a lighter fraction to be transported with the gas fraction and a heavy fraction to be transported with the liquid fraction.

When transporting a liquid petroleum fraction containing heavy gases such as propane and butane at a moderate gauge pressure of the order of 1.05 to 1.07 bar, gases will continuously evaporate from the liquid fraction. To avoid a pressure increase in the transport tanks, the evaporating gases, i.e. the volatile organic compounds, must be drawn off from the tanks and sent to combustion or a reinjection plant.

NO 19996471 concerns a downcomer provided with a venturi, the venturi being designed to condense already separated gases from a cargo hold. By using a venturi to increase the fluid velocity and thereby the underpressure, unnecessary evaporation of VOC is anticipated due to the relatively low pressure.

The object of the invention is to remedy the disadvantages of prior art.

The object is achieved in accordance with the invention, by the characteristics given in the description below and in the following claims.

A downcomer is provided from a level above the deck of the ship and down into the ship's cargo tank, preferably ending up near the bottom section of the cargo tank. Fluid is pumped from the cargo tank and up to the upper part of the downcomer. When the oil flows into the upper end portion of the downcomer and is accelerated by gravity, a lower total pressure is created in the upper part of the downcomer. This underpressure can be reduced by introducing gas into the upper part of the downcomer. According to the invention, this

gas is made up of already evaporated gas from the void above the liquid cargo in the cargo tank.

The upper part of the downcomer is disposed at a height that ensures a sufficient drop in the downcomer, even with a full
5 cargo tank.

The so-called Froude number is known from the fluid mechanics of open pipes. The Froude number Fr , which is dimensionless, is defined as the ratio between the force of inertia and the force of gravity acting on a fluid:

10

$$Fr = \frac{V}{\sqrt{gh_m}}$$

Where V = fluid velocity in metres per second, g = Earth's gravity in metres per second², and h_m = the mean hydraulic depth.

Replacing the hydraulic depth h_m in the formula with the
15 diameter D of the downcomer produces an expression that has proven to be appropriate for the selection of suitable downcomers.

The development work carried out has shown that the absorption of VOC gases into the oil is satisfactory when the
20 value of the expression

$$Fr = \frac{V}{\sqrt{gD}}$$

is between 1 and 2.

Thus the diameter of the downcomer is chiefly dependent on the velocity of the inflowing fluid.

In the following, a description is given of a non-limiting
5 example of a preferred device illustrated in the accompanying drawings, in which:

Figure 1 schematically shows an arrangement in which the oil is pumped from the cargo tank of a tanker to the upper part of the downcomer; and

10 Figure 2 shows the upper part of the downcomer on a larger scale.

In the drawings, reference number 1 denotes a tanker. A pump 2 is connected to one or more of the ship's cargo tanks 4 and arranged so as to pump oil from the cargo tank 4 up to the
15 upper part 8 of a downcomer 6 via a pipe 10. If so desired, the pipe 10 can be connected to a cooling unit 12 in order to improve the condensation process in the downcomer 6.

A gas pipe 14 runs from the upper part 16 of the cargo tank 4 to the upper part 8 of the downcomer 6.

20 The upper end 8 of the downcomer 6 projects far enough above the upper part 16 of the cargo tank 4 to create a sufficient underpressure at the end portion 8, even when the cargo tank 4 is filled up.,

The pump 2 is started and oil flows from the bottom of the cargo tank 4 via the pipe 10, and possibly via the cooling unit 12, up to the upper part 8 of the downcomer 6. When the oil flows down through the downcomer 6, the gravitational force, which seeks to increase the falling velocity in the downcomer 6, will give rise to a reduced total pressure by the upper part 8 of the downcomer 6.

Gas located in the upper part 16 of the cargo tank 4 will then be drawn through the gas pipe 14, which is appropriately dimensioned, and into the upper part 8 of the downcomer 6, where the inflow of gas prevents the build-up of a relatively large underpressure in the upper part 8. The inflowing gas is mixed with and condensed into the oil as it flows down through the downcomer.

The intake of gases from the gas pipe 14 at the upper part 8 of the downcomer 6 is, according to the invention, only due to the underpressure that is created as a result of the inflowing oil falling down through the downcomer 6. Emphasis is placed on avoiding reductions in the cross section of the downcomer 6, as such reductions will cause VOC to separate out of the oil.

Moving transport tanks are more susceptible to evaporation of VOC, but the device according to the invention is equally well suited for use with stationary storage tanks.

C l a i m s

1. A device for condensing volatile organic compounds (VOC) from a storage or transport tank (4) into oil from the same or another storage or transport tank (4) via a downcomer (6), c h a r a c t e r i z e d i n
5 that the upper part (8) of the downcomer (6), which upper part has a cross sectional area that is substantially unreduced, is connected to a gas pipe (14), the gas pipe (14) communicating with the upper
10 part (16) of the storage or transport tank (4), and where the upper part (8) of the downcomer (6) is arranged at a sufficient height above the upper part (16) of the storage or transport tank (4) to cause an inflow of gas from the upper part (16) of the storage or
15 transport tank (4) due to the underpressure being created in the upper part (8) of the downcomer (6) when oil flows down through the downcomer (6).

2. A device in accordance with Claim 1,
c h a r a c t e r i z e d i n that the oil flows
20 through a cooler (12) prior to flowing into the upper part (8) of the downcomer (6).

1/2

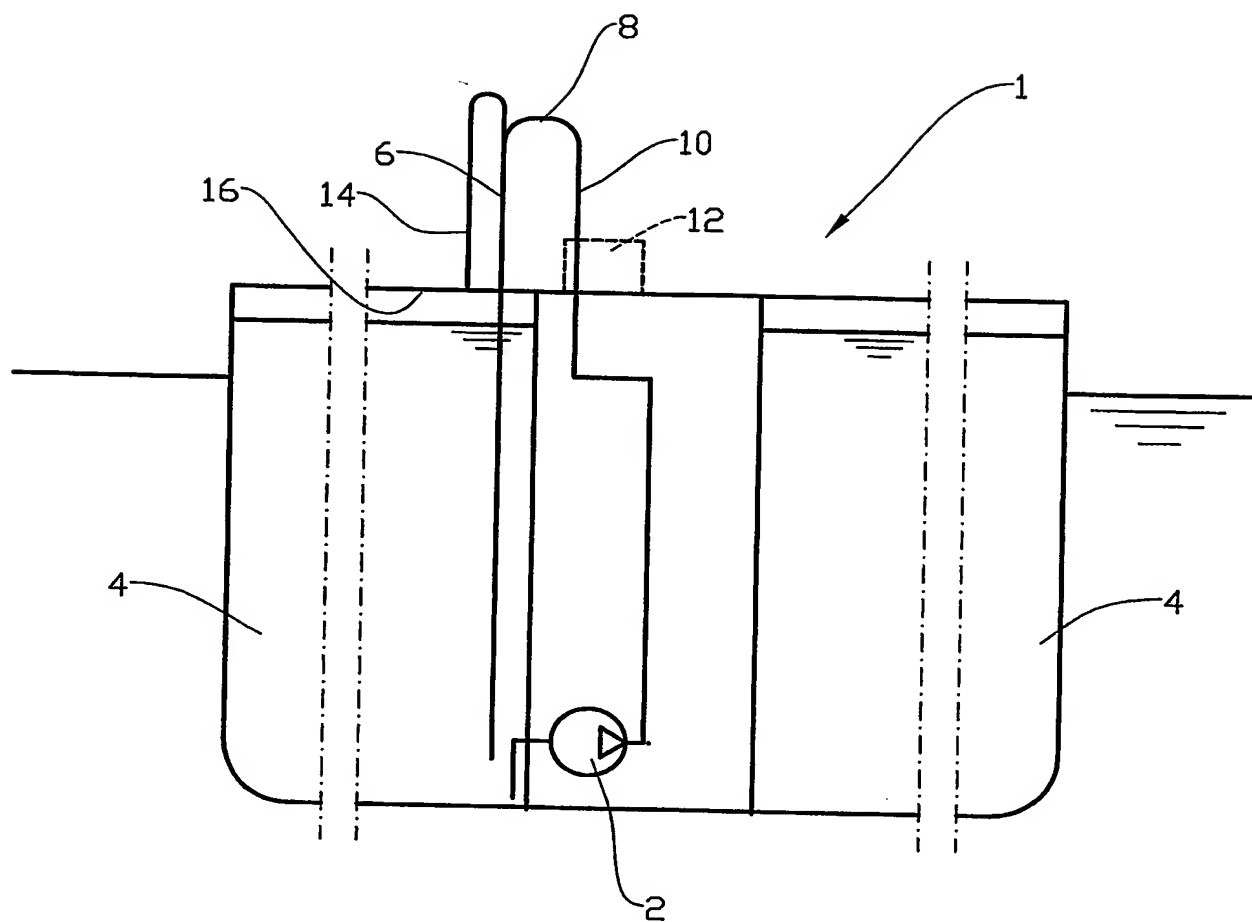


Fig. 1

2/2

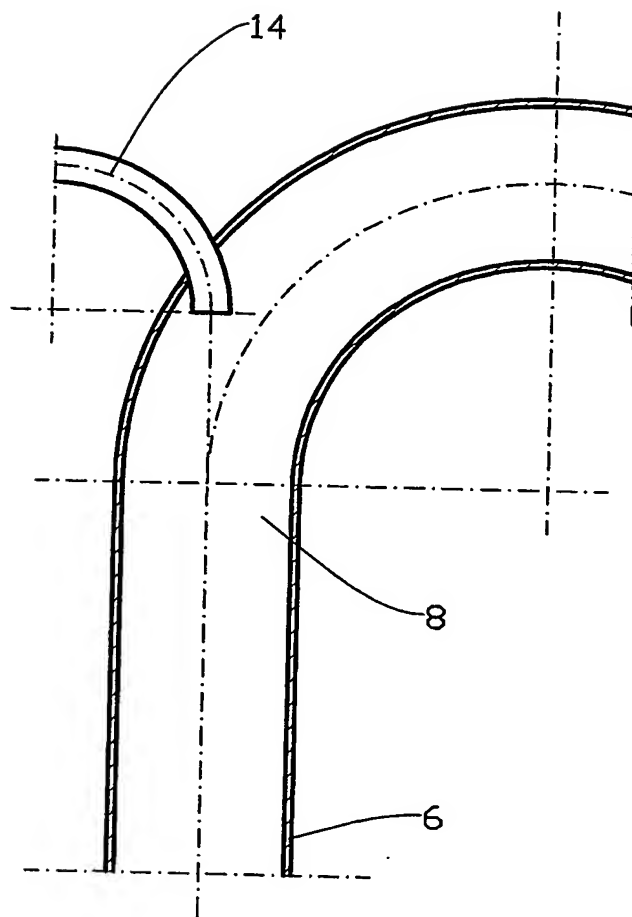


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 2003/000433

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F17B 1/14, B01D 5/00, B65D 90/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F17B, B01D, F17C, B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3068657 A (J.C. ALLEN), 18 December 1962 (18.12.1962), whole document --	1-2
A	US 2944405 A (C.A. BASORE ET AL), 12 July 1960 (12.07.1960), whole document --	1-2
A	US 3369371 A (R.J. HOLLY ET AL), 20 February 1968 (20.02.1968), whole document -- -----	1-2

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

3 March 2004

Date of mailing of the international search report

04 -03- 2004

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Anna R-Salomonsson / MRo

Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

24/12/2003

International application No.

PCT/NO 2003/000433

US	3068657	A	18/12/1962	NONE
----	---------	---	------------	------

US	2944405	A	12/07/1960	NONE
----	---------	---	------------	------

US	3369371	A	20/02/1968	NONE
----	---------	---	------------	------